APPENDIX:

The Appendix includes the following item(s):

- copy of Experimental Report

(b)

BENSC

EXPERIMENTAL REPORT

Magnetic structure of $Ho_2Co_{15}Si_2$

Proposal N° PHY-01-980
Instrument E6
Local Contact
N. Stüßer

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Date(s) of Experiment
19/03/2001-26/03/2001

Date of Report: 30/01/2002

In a recent article [1], we reported on the magnetic properties of a single-crystalline sample of the ferrimagnetic pseudobinary compound $Ho_2Co_{15}Si_2$. The crystal structure is the rhombohedral Th_2Zn_{17}-type of structure. The Curie-temperature is T_C = 837 K, below which ferrimagnetic order with the Ho and Co magnetic moments ordered antiparallel occurs. Between T_C and T_{SR} ~ 320 K, the easy magnetization direction is the c-axis, i.e. the moments are aligned along the c-axis. At a temperature near 320 K, a spin-reorientation transition takes place, leading to an easy magnetization direction perpendicular to the c-axis. This spin-reorientation transition is ascribed to competing magnetic anisotropies of the Ho and Co sublattices. Above T_{SR}, 320 K, the magnetic anisotropy is dominated by the Co sublattice anisotropy, favoring an easy-axis configuration. Below T_{SR}, the magnetic anisotropy is dominated by the Ho sublattice anisotropy, favoring an easy-plane configuration. Upon further lowering the temperature, the Ho ordered magnetic moments increase, and near 30 K compensate the antiparallel ordered Co magnetic moments.

The focus of this work lies with the spin-reorientation transition near 320 K. We performed magnetization experiments on our single-crystal near the spin-reorientation transition temperature [1]. The saturation magnetization with the field applied along the c-axis is higher (by about 0.6 μ_B/f.u.) than with the field applied perpendicular to the c-axis. This magnetization anisotropy occurs both above and below the spin-reorientation temperature, thus regardless of the easy magnetization direction. Which magnetic sublattice is responsible for the magnetization anisotropy, the Ho or the Co magnetic sublattice (or both) is to be found out.

A polycrystalline sample of $Ho_2Co_{15}Si_2$ was prepared. Magnetization measurements showed that for this sample, the Curie temperature is near T_C = 830 K, and the spin-reorientation temperature is near T_{SR} = 295 K.

We performed powder neutron diffraction in the instrument E6. A high temperature oven and an Orange cryostat weres used to reach temperatures above the Curie temperature and below room temperature. The neutron wavelength was 2.44 Å. Diffractograms were measured at various temperatures. Most of the observed reflections could be indexed on the basis of the Th_2Zn_{17}-type of structure (space group R-3m). Generally, gradually increasing intensity was observed on top of the nuclear reflections when the temperature was gradually lowered. An exception to this is found near the spin-reorientation temperature. Figure 1 shows the diffractogram measured at 274 K, together with the difference of this diffractogram with that measured at 302 K. The main reflections that change are indexed. The decrease of the (110)/(210) reflections and the increase of the (003) reflection is in agreement with a reorientation from easy axis to easy plane.

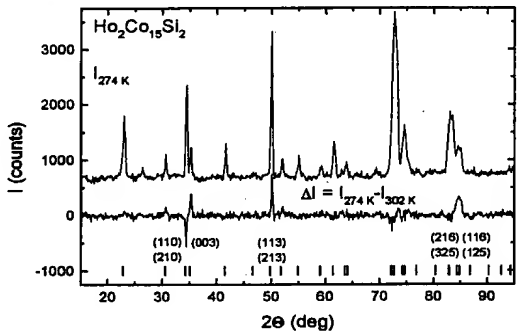

Figure 1: Powder neutron diffractogram measured at 274 K (above). Difference between diffractograms measured at 302 K and 274 K (below).

Preliminary Rietveld-type analysis proved difficult, because of the large number of parameters to be refined for this crystal structure. We are currently performing single-crystal X-ray diffraction. Awaiting the results, we are planning to analyse the neutron diffraction data in detail in the near future.

[1] O. Tegus et al., J. Alloys Comp. 302(2000) 21